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(54) Electromagnetic device with stator displacement regulation

(57) A stator (4) is constructed by spirally disposing around the central axis thereof a plurality of magnetic plates (8) each having a uniform thickness and being bent in a curved shape. A support body (10) is so assembled to the stator as to abut its bottom face and a through hole (7). The support body has a disk part (10a) having an outer diameter generally corresponding to that of the stator and a cylindrical part (10b) extending upwardly from the central part of the disk part. The top end part of the cylindrical part is fixedly joined to the stator by the laser welding. A push rod (11) coupled with an armature (12) is disposed slidably in a hole (10c) of the support body. The bottom face of a cap housing (13) abuts the peripheral part of the top face of the stator to press the peripheral part from the upperside.

FIG. 1

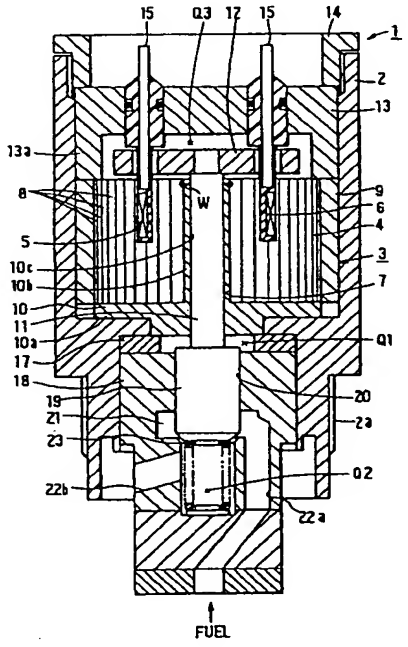

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Fig. 6 is a cross sectional view showing the assembling process of the stator assembly;

Fig. 7 is a cross sectional view showing a construction of a stator assembly according to a second embodiment;

Fig. 8 is a cross sectional view showing a construction of a stator assembly according to a third embodiment;

Fig. 9 is a cross sectional view showing a construction of a stator assembly according to a fourth embodiment;

Fig. 10 is a perspective view showing a shape of a support body according to a fifth embodiment;

Fig. 11 is a cross sectional view showing a construction of a stator assembly according to a sixth embodiment;

Fig. 12 is a cross sectional view showing the construction of the stator assembly according to the sixth embodiment;

Fig. 13 is a cross sectional view showing an electromagnetic device according to a seventh embodiment;

Fig. 14 is a cross sectional view showing a conventional construction of a stator assembly;

Fig. 15 is a cross sectional view showing another conventional construction of a stator; and

Figs. 16(a) and 16(b) are a plan view and a cross sectional view showing the another conventional construction of the stator assembly shown in Fig. 15.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENT

The present invention is described in detail with reference to the accompanying drawings in which the same reference numerals are used to designate the same or like parts throuout the various embodiments.

(First Embodiment)

In the first embodiment shown in Fig. 1, an electromagnetic device 1 is used as an electromagnetically-operated fuel spill valve for fuel injection pump of a diesel engine so that the valve operates as a normally-open type valve. That is, during the normal operation in which a solenoid coil is deenergized, a valve body is kept to open a fuel passage by a biasing force of a biasing spring. With the solenoid coil being energized, the valve body moves against the biasing force of the biasing member to close the fuel passage.

In the electromagnetic device 1, a solenoid housing 2 is shaped generally cylindrically and is formed a thread 2a at the bottom outer periphery thereof for attaching the electromagnetic valve to a fuel injection pump not shown. A stator assembly 3 is fitted inside the solenoid housing 2. The stator assembly 3 has a solenoid stator (simply referred to as stator hereunder) 4. The stator 4 is formed an annular coil insertion groove 5 opening upwardly in the figure so that a coil 6 is wound in the insertion groove 5. The stator 4 is also formed a through hole 7 passing axially centrally (in up-down direction in the figure).

As shown in Figs. 2, the stator 4 has a stacked construction of a number of magnetic plates 8. As shown in Fig. 3, a silicon steel plate of uniform thickness is used for the plate 8. The silicon steel plate 8 is press-punched to form a rectangular cut-out or recess 8a and is bent in a curved shape longitudinally. Each plate 8 is disposed spirally around the central axis of the stator 4 by the aid of a certain jig or the like and its outer periphery is fixed circularly so that the stator 4 is assembled generally cylindrically as shown in Fig. 2. By this assembling, the coil insertion groove 5 is formed by the recess 8a of the plate 8.

As shown in Fig. 1 further, a ring 9 is fitted around the outer periphery of the stator 4. At the time of fitting the stator 4 with the ring 9, the spirally formed stator 4 is press-inserted against the inner peripheral face of the ring 9.

A support body 10 is assembled with the stator 4 in such a manner to abut the bottom face and the through hole 7 of the stator 4. The support body 10 is generally in a T-shape in cross section, and has a circular disk part 10a having generally the same outer diameter as that of the stator 4 and a cylindrical part 10b extending upwardly from the central part of the disk part 10a. A hole 10c is formed centrally in the support body 10. As shown in Fig. 4, the cylindrical part 10b of the support body 10 is press-fitted into the through hole 7 of the stator 4. In press-fitting the support body 10, the ring 9 may be fitted around the stator 4 after the support body 10 has been press-fitted into the stator 4, or alternatively the support body 10 may be press-fitted with the stator 4 with the ring 9 fitted around the stator 4.

As shown in Fig. 1, the length of the cylindrical part 10b of the support body 10 is slightly shorter than the height (axial length) of the stator 4. The top end part of the cylindrical part 10b is fixed to the stator 4, i.e., to all the radially inner peripheral end of the magnetic plates 8a, by laser welding. The welded part is indicated by W in Fig. 1.

A push rod 11 is positioned in the hole 10c of the support body 10 axially slidably (in an up-down direction in the figure). An armature 12 is coupled with the top end of the push rod 11. The armature 12 is so arranged as to be attracted toward the top face (magnetic pole face) of the stator 4 by the magnetic force generated at the time of energization of the coil 6.

A cap housing 13 is mounted above the armature 12 in a manner to tightly abut the inner peripheral face of the solenoid housing 2. The cap housing 13 has an annular peripheral part 13a extending axially downwardly. The bottom face of the annular peripheral part 13a is in abutment with both the top peripheral end part of the stator 4 and the top end face of the ring 9. With a locking nut 14 threaded into the top end part of the solenoid housing 2, the cap housing 13 is fixed in position

sages 22a and 22b in the electromagnetic valve 1 cannot be interrupted completely, causing degradation of the performance of the electromagnetic device 1 used as a valve unit. According to the present embodiment, however, such a drawback will not occur because the displacement of the stator 4 is regulated. Thus, the performance of the electromagnetic device 1 used as a valve unit can be maintained.

(Second Embodiment)

In Fig. 7, the support body 10 as the first position regulating member is constructed by the disk part 10a and the cylindrical part 10b manufactured separately from each other. Although these disk part 10a and the cylindrical part 10b are separated into two parts, the two parts 10a and 10b are engaged into an integral body by respective stepped potions 10d and 10e, and the axial top end part of the cylindrical part 1b is welded to the stator 4 as indicated by W. At the time of welding by the laser welder, the top peripheral face part of the stator 4 and the top face of the ring 9 are pressed by the jig 25 which corresponds to the cap housing 13 of the electromagnetic device.

According to this embodiment, the following advantages are provided in addition to those provided in the first embodiment. That is, with the support body 10 being constructed by the disk part 10a and the cylindrical part 10b separately manufactured, material machining is eased and other workability in the various processes such as drilling is improved in comparison with the first embodiment in which the T-shaped support body 10 is integrally manufactured. Further, since the part to be chipped by the machining is reduced, the material cost is reduced and cost reduction is attained.

(Third Embodiment)

In Fig. 8, the support body 10 as the first position regulating member is constructed by the disk part 10a and the cylindrical part 10b manufactured separately as in the second embodiment. A stepped part 7a is formed on the top end of the through hole 7 of the stator 4 and a radially enlarged part 10f is formed on the top end of the cylindrical part 10b of the support body 10 in correspondence with the stepped part 7a. After the cylindrical part 10b is inserted into the through hole 7, the bottom end of the cylindrical part 10b and the bottom face of the disk part 10a are welded by the laser welder so that those parts 10a and 10b are integrated at the bottom as indicated W. At the time of welding by the laser welder, the top peripheral face part of the stator 4 and the top face of the ring 9 are pressed by the jig 25 which corresponds to the cap housing 13 of the electromagnetic device.

According to the present embodiment, in addition to the advantages provided in the first embodiment, advantages of machining simplification and cost reduction can be also provided as described in the second embodiment.

(Fourth Embodiment)

In Fig. 9, the support body 10 as the first position regulating member is constructed by the disk part 10a and the cylindrical part 10b manufactured separately as in the first and second embodiments. A tapered face 7b is formed on the top end of the through hole 7 of the stator 4 and a conical part 10g is formed on the top end of the cylindrical part 10b of the support body 10 in correspondence with the tapered face 7b. with the cylindrical part 10b being inserted into the through hole 7, the bottom end of the cylindrical part 10b and the bottom face of the disk part 10a are welded by the laser welder so that those parts 10a and 10b are integrated at the welded part indicated by W.

According to the present embodiment, in addition to the advantages of the first embodiment, advantages of machining simplification and cost reduction can be also provided as described in the second embodiment.

(Fifth Embodiment)

In Fig. 10(a), the support body 33 as the first position regulating member is constructed by a bottom part 10a formed in a generally cross-shape and a cylindrical part 10b raised vertically from the central part of the bottom part 10a. As shown in Fig. 10(b), the bottom part 10a may be formed in an elongated plate shape. The cylindrical part 10b of the support body 10 is inserted from the underside of the stator 4 and the top end of the cylindrical part 10b is welded as in the first embodiment. In this embodiment, the bottom part 10a which abuts the bottom face of the stator 4 may be changed to any shape as desired. It may be may be changed to three lateral extensions or may be formed in a polygonal shape.

In this embodiment, the bottom part 10a and the cylindrical part 10b may be manufactured integrally or separately. As described in each of the foregoing embodiments, the support body 10 may be constructed by welding two separate members.

(Sixth Embodiment)

In Fig. 11, The support body 10 as the first position regulating member is formed in the disk shape and assembled to abut the bottom face of the stator 4. The support body 10 is formed at the central part thereof a hole 10h having the same diameter as the through hole 7 of the stator 4. A bushing 62 is fitted in the through hole 7 of the stator 4 and the ring 9 is fitted around the outer periphery of the stator 4. The boundary between the through hole 7 and the hole 61a is welded by the laser welder as indicated by W with the bottom face of the stator 4 and the support body 10 being in contact with each other so that these members 4 and 10 are

of a magnetic pole face of the stator opposing the armature; and

the first position regulating member has a position regulating part (10b - 10h, W) for regulating, in a position from the abutment part to a through hole at a central part of the stator, the axial position of the magnetic plates.

4. An electromagnetic device according to claim 3, wherein:

the position regulating part has a cylindrical part (10b, W) welded to a radially inner end face of the magnetic plates within the through hole of the stator.

5. An electromagnetic device according to claim 3, wherein:

the position regulating part has an engagement part (10d - 10g) engaged with a radially end face of the magnetic plates within the through hole of the stator.

6. An electromagnetic device according to claim 1 or 2, wherein:

the first position regulating member is in abutment with an opposite face of a magnetic pole face opposing an armature and is welded to the magnetic plates within a through hole at a central part of the stator.

FIG. 2

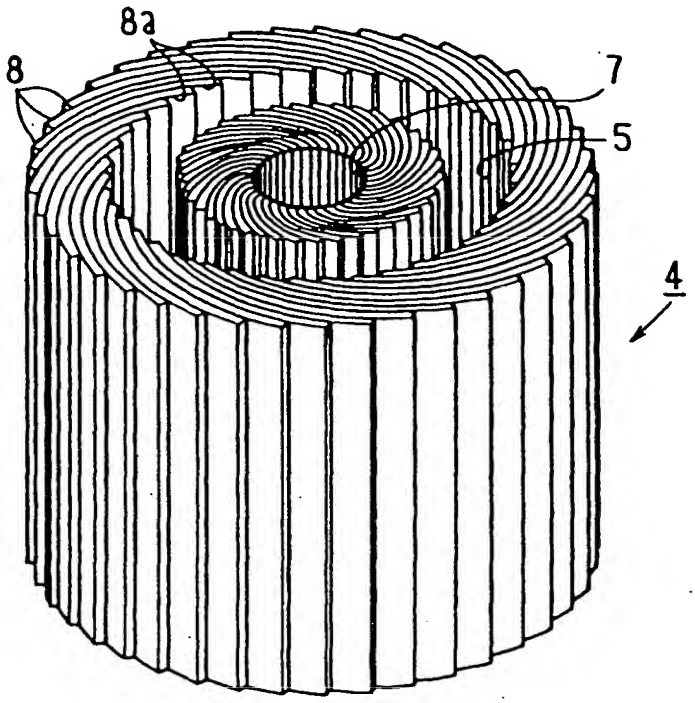

FIG. 3

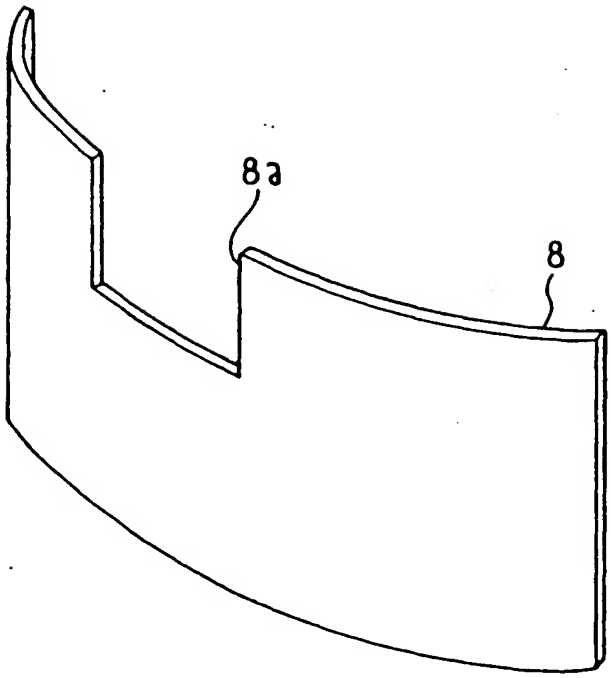

FIG. 5

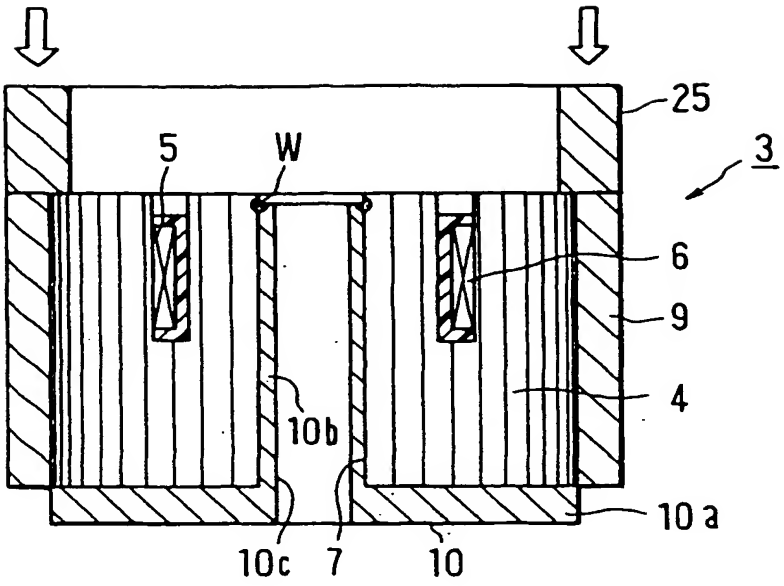

FIG. 6

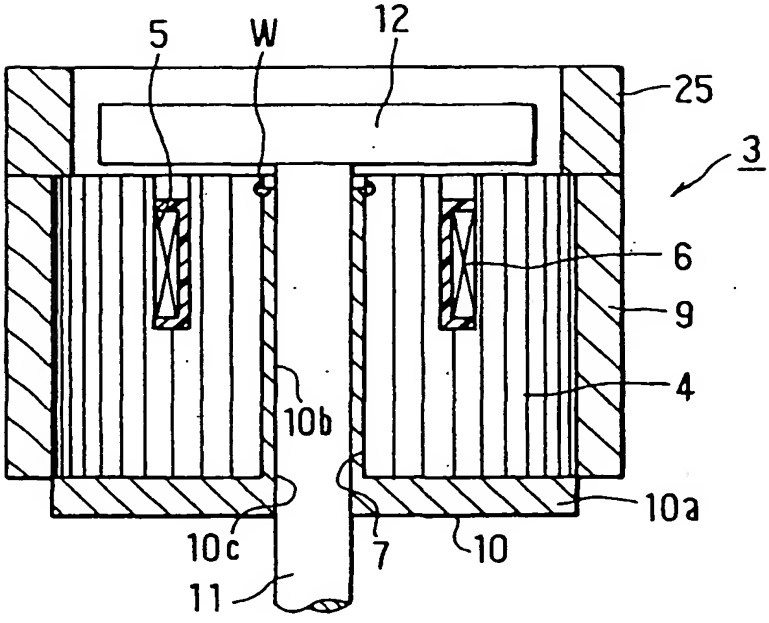

FIG. 9

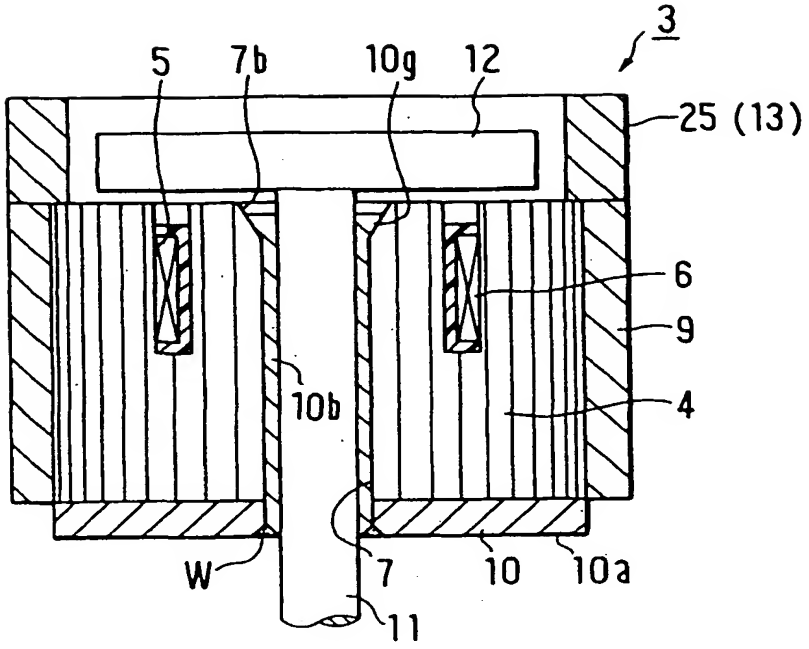

FIG. 10(a)

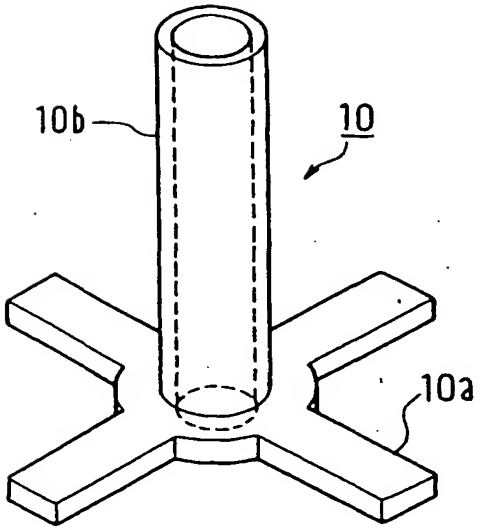

FIG. 10(b)

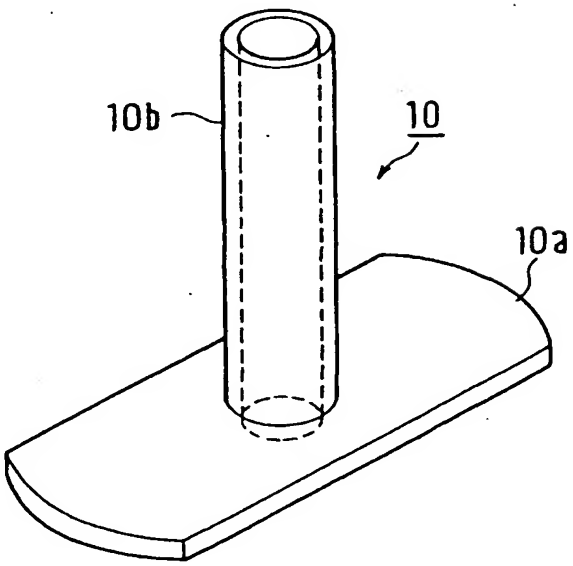

FIG. 13

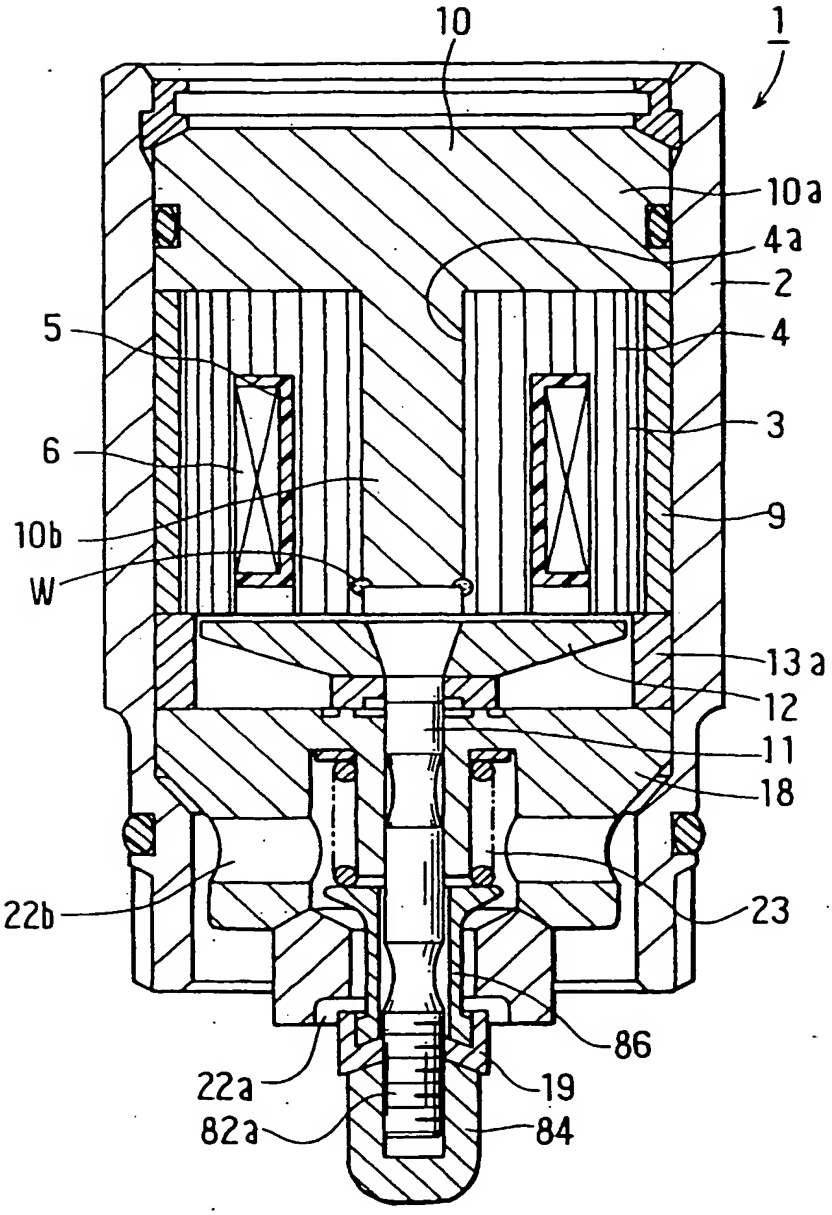

FIG. 16(a)
PRIOR ART

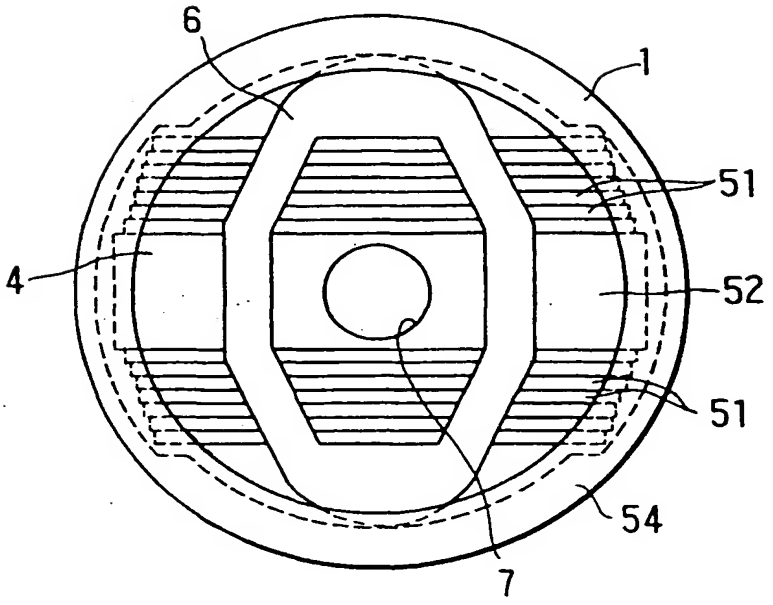

FIG. 16(b)
PRIOR ART